"The Changing Higher Education Context"
REMARKS BY DR. G. WAYNE CLOUGH
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It is an honor to join my distinguished colleagues, Presidents Casteen and Young, to address the changing context of higher education. Let me point out that while I may not look it, I am the babe in the woods on this panel. Both John and Chuck have been presidents for much longer than myself and at two institutions each. On the other hand, I am the engineer of the bunch and have been both a department chair and a dean of an engineering college along the way. Conceding to John's and Chuck's experience, and since I have walked in your shoes, I thought today it might be helpful to focus my comments about higher education from that perspective. The title of my remarks might be "The Changing Context for Higher Education – An Engineering Perspective."

At the outset I would say that the opportunity exists today for engineering to play a larger role than ever before in higher education, and for society for that matter. After all, technology is more pervasive in education and society than ever before, but whether engineering takes advantage of the situation depends upon decisions engineering education leaders take today. It will depend on how we configure our curriculum for the future and hence, the type of knowledge, skills and vision we

provide engineering graduates to cope with the future. It will depend on our ability to attract talent from a student pool that is growing more diverse and on our ability to reinvirgorate federal support for engineering research. It will depend on the willingness of engineers, particularly in the academic community, to engage themselves in the world of public policy and help change the image of engineering with the public. This is something I am worrying about with a group of colleagues who are working on the "Engineer of 2020 Project" an initiative of the National Academy of Engineering and its president, Bill Wulf, and of the NAE Committee on Engineering Education, chaired by your own Steve Director. More about this later.

Our topic today is about higher education and the changes taking place in and around it. There is no question that change is occurring and have had, and are having, a major impact on higher education. I think we would agree on most of the drivers, although my take on them is that they often have differing perspectives when it comes to engineering. My list would include:

Economics, especially for state institutions; technological developments; world events (e.g., September 11th); federal and state policy decisions about higher education; research funding trends; shifts in student interests; changing

demographics; increasing expectations and accountability; and the clash of the ponderous pace of university governance with the rapid pace of change in society,

There is plenty going on that will change what we do, but we have to be careful to sort out those factors that will have long term effects and not over-react to the signals we are getting. Remember all of those meetings many of us had with our faculty and university administrators about the Total Quality Management movement and how much of a stir that created? Some good things resulted, but universities quietly remained largely the same after the whirlwind passed.

Or, remember how many times we have been told we might go out of business because of distance learning technologies and the outfits that were cropping up as electronic universities? Something did come from all of this, but we, and many experts, misread the tea leaves. Traditional universities took action and are gaining a significant share of what turned out to be a distance learning market that really works best for most people primarily as a supplement to conventional face to face education. Visions of **hordes** of students taking courses via distance learning are being replaced with the **reality** of hundreds of thousands of students on traditional campuses accessing information, being provided with course support materials, doing campus business, and interacting with fellow students and faculty, all using

the internet. And, along with the teaching and learning environment, most universities today have dramatically altered their way they do business by heavily investing in internet based technologies. So we are significantly changed by information technology and the internet, but in ways we did not foresee because our vision was clouded.

Clearly there is a new context for higher education, and each force driving it deserves its own discussion. However, given the time I have and the remarks of my colleagues who are also speaking, I would like to limit the remainder of my comments to issues unique to engineering and engineering education.

First, consider research funding and the trends in this area. ~~It is a given that a strong research funding base is critical for engineering to development of the next generation of ideas and to the strength of our graduate programs~~. The context for research funding is one of those things that changed in the past fifteen years. As the cold war waned, federal concerns focused on health issues while industry became more and more driven by short term expectations. Over the past fifteen years, the commitment of the federal government to R&D dropped from 1.5% of the GDP to 0.6%. Along with this trend, a larger share of what was left went to NIH and other health related agencies. Next year will be the last of five years of a

plan Congress set into to place to double NIH funding. At that time NIH's annual R&D budget will be over $28 billion, while NSF's will be a mere $4 billion. In terms of constant dollars, the federal investment in R&D for other than health fields is essentially the same as it was ten years ago. Added to this is the long term reduction of support for graduate fellowships.

During the past decade, many key fields in engineering have seen federal funding diminish. A recent NRC report showed that federal funding for research for mechanical engineering dropped by 40% from 1993 to 1999. Electrical engineering also saw significant declines. This led investigators to shift from federal to industry support, which has a good side and not so good side. It is good that engineering research is attuned to the needs of industry, but if present trends continue, engineering research may be driven too strongly towards short term results. ~~Who will be left to make the discoveries that come from long term research that will benefit us 20 or 30 years from now?~~

These patterns need to be examined to make sure we have a healthy blend of efforts that will yield results of practical value, but also will produce the kind of profound breakthroughs that come from long term research. President Bush has charged his Council of Advisors for Science and Technology, PCAST, to consider the balance of research funding, to review technology transfer systems to insure we

are equipped to obtain the appropriate economic benefit from research, and to recommend on which research areas need more support and which ones need less. Since I am fortunate to chair the PCAST panel on R&D, I can say with confidence we will look hard at the important areas that are not being appropriately addressed. But this will be only the first step in a long process. The key will be the follow-through that is needed to make sure the issues are understood by key members of congress since they ultimately appropriate federal funds. Engineers and scientists need to join forces and get active to help our governmental representatives understand the issues and make the case for the needed federal research support.

The second issue I would like to comment on is shifts in demographics and student interests. For two decades now numbers of engineering graduates nationally have declined with the exception of only a few years. In a telling shift, four years ago the numbers of students majoring in parks and recreation began to exceed those majoring in electrical engineering. This trend has accentuated since then. Part of our problem in attracting more students to engineering has been that we have not worked aggressively enough to recruit our share of women and minorities. While women and minorities have increased their presence in engineering in the past twenty years, their numbers have stagnated recently. Three years ago Georgia Tech began working with a group of leading universities in the belief that this

problem was resistant to conventional approaches and required a new one. First, this new effort would be based on the efforts of a national team of institutions working from a common strategy, not just that of individual universities working from their own songsheet. Second, it would make use of technology to reach audiences who had not been reached before. Third, it would formulate an approach that covers the spectrum from K to Ph.D level education because to do less leaves out a key component of the picture.

The initiative, called EMERGE (Empowering Minority Engineers to Reach for Graduate Education), uses the web to link universities, key corporate partners, government agencies and K-12 schools. Students and teachers at any grade level will be able to access information about engineering and science, see interactive learning experiments, locate educational materials for classroom activities, communicate directly to the universities and agencies, and find out how to apply for summer programs, internships, college study and even graduate school. The web approach will also target links to faith-based institutions that are important to reach many minority students and their parents. These institutions in growing numbers have their own computing centers and web capabilities and provide computer access to segments of society that have not been served by the internet before.

EMERGE is based upon a partnership of universities including Carnegie Mellon, MIT, North Carolina A&T, Morehouse College, University of Michigan, Arizona State University, Cal Tech and Georgia Tech among others and is supported by the National Science Foundation as well as the member institutions. It allows the universities to reach out to students in places where they live, go to school and experience community activities, as well as to involve their parents. Beyond the web based approach, EMERGE members work with each other and other institutions through regular meetings and back in their own communities they provide the personal touch through partnerships with school districts and charter schools.

Will EMERGE be successful? It is too early to tell, but at least we are not doing the same old, same old. We believe we will be able to encourage the interest of women an minorities in engineering and science in ways not achieved before and help improve the pool of qualified students at undergraduate and graduate levels. EMERGE is but one example of the kind of innovative thinking we need more of if we are going to truly make a difference in the numbers of women and minorities participating in engineering.

Finally, I would like to comment on engineering education as it relates to the changed future for higher education. More than 50 years ago the engineer Saul Belilove wrote an article in *The Journal of Higher Education*, in which he foresaw a changed context for higher education. He envisioned a world of rapid of technological change and widespread use of technology. And he predicted that our society would increasingly need the leadership of engineers in broader roles for which a purely technological education would not provide adequate preparation. It is imperative, he wrote, "that their sense of responsibility and their ability to contribute to the spirit and life of our civilization be consistent with the great powers they will wield... Engineers," he said, "must become adept statesmen in dealing with economic and social problems."

Over the following decades, the world Belilove had envisioned took shape as he had predicted, ~~In the process, technology has assumed a more central role at the core of society, the interaction between culture and technology has become much more significant.~~

Over the course of the past century, we have invented and put to use a wide range of incredible technology in a rather decentralized, disjointed fashion. Now we are taking a look around us and realizing that the world in which we live is largely a

product of all of those disparate engineering efforts. And the engineering decisions we used to regard as unrelated to social, political, and economic concerns have in fact become tightly interwoven with them. Technology and social change have become a double helix – two strands that are inextricably intertwined. ~~Yet with few exceptions, engineers are not involved in making the decisions that affect how technology is used.~~

If we had thought about Belilove's insights engineering education might have been designed in a way to help engineers become more useful to society than just in a technical sense. Instead, today we have a curriculum that is designed in the 1990's based on events that occurred in the 1980's, and that provides the education for engineers who will populate the workforce of 2010 and beyond. The NAE initiative, "Engineer of 2020" ~~I mentioned earlier~~, contends this is not good enough. It proposes that we should have the audacity to imagine what we want engineering to be in 2020, and shape the curriculum so the engineering talent fit that era, not one of the past.

The initiative is designed to help us understand how we might do this by bringing together creative minds to anticipate possible scenerios for the future so we can shape engineering education to graduate engineers who can be better prepared for

that future. It is my honor to chair this two year initiative. But it is important to note that we report to the engineering education committee of NAE chaired by Steve Director. This is important because ultimately if engineering education does not change, then nothing will change.

We can make some reasonable guesses about some of the broader outcomes of this project. To some extent it will help us explore the technical domains and the events that might drive technical changes that will shape our future. And these are exciting. But it will also likely look to a larger role that the engineer in 2020 should be capable of filling. As George Fisher, chairman of Eastman Kodak Company, recently wrote in NAE's *Bridge,* "Integrating human needs is engineering's biggest challenge."

The skills and perceptions of engineers make them better suited than ever before in history to play a broader leadership in today's technological world, but this will happen only if they are prepared for it. At Georgia Tech we are seeking to help by introducing leadership classes and exercises that will cross the curriculum for our engineering students as well as for the other majors on our campus. Every student will be able to avail themselves of opportunities to learn about leadership as well as to practice it. Good leadership education should have the side benefit of

developing the characteristics that we hope to see in good engineers now, including being facilitators, open to new ideas, team players, good listeners, understanding of different cultures, and good communicators. And by entrepreneurship.

If our students learn about leadership, they will understand that because technology is a driving force in public policy, engineers should play a greater role in informing and shaping policy decisions. It is not a stretch to say that if good engineering thinking had been applied to California's energy deregulation plan, the outcome would have been completely different than what occurred.

Environmental sustainability is another issue that demands engineers who exercise their expertise in a broader social and cultural context. Recent news stories have reaffirmed that political solutions to problems like global warming are very difficult. Engineers can play a role by helping our graduates understand the principles of sustainable technology and how it helps to reconcile the conflict between economic development and environmental conservation.

Sadly, public perception surveys show that 85 percent of the general public believe scientists help solve our environmental problems, but only 5 percent believe engineers contribute. In a lot of respects, engineering is a "stealth" profession. At

best, most people know that engineers design engines and their components. We need to not only help solve the problems, but advance the solutions in the context of public policy so that we participate in the highly visible "front room" activities as well as the "back room" work of developing the technology.

These examples are but a few of those that we need to address and understand if we are to create a curriculum that will produce an engineer for 2020 who does not look and think like an engineer of 2000. The question has been asked about how the context for higher education has changed. It has, and it is time for engineering education to not only react, but take the initiative. Whether it is through enhanced research activity, opening our profession to all elements of society, or educating a new generation of engineers with a broader view, we must take positive action ourselves and not wait for events to occur that will control us. Our past shows this is not the way to succeed in the future.